META2.0, status update, 2015-07-08

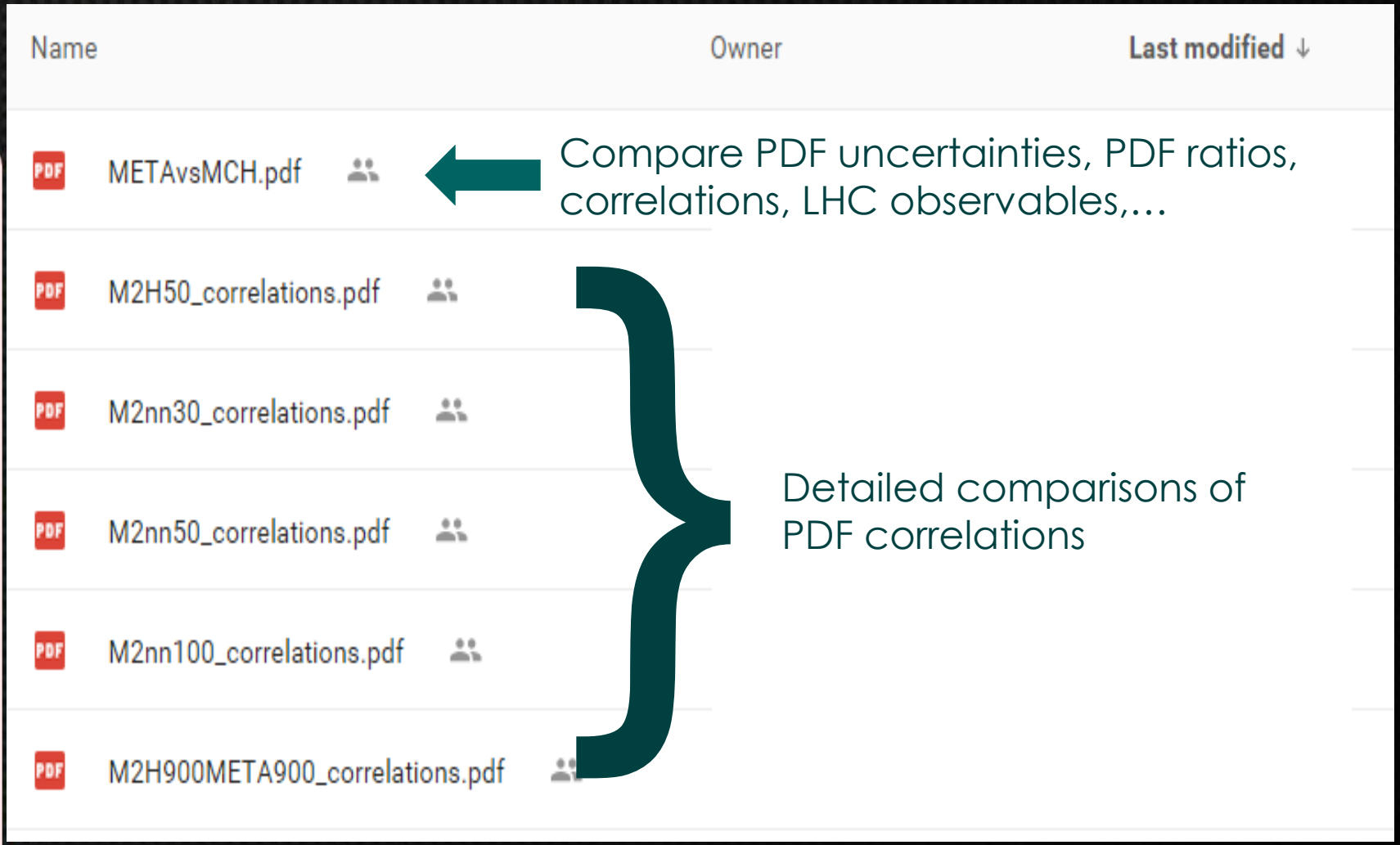
- The META combination is redone using consistent settings with the latest MC2Hessian combination
- Two groups of ensembles, starting with 900 MC replicas:

1. META900 (from MP4LHC) ⇒ META100, META50, META30
2. MCH900 (from MC2Hessian) ⇒ METAalt100, …50, …30

- Hessian ensembles for 100, 50, 30 eigenvalues
- 1 error set per 1 eigenvalue ⇒ simplest Hessian uncertainties
- Fit differences from the average $f_0(x, Q_0)$ of META900 in increased x range $[3 \cdot 10^{-5}, 0.9]$, in the flavor basis; Bernstein polynomials, without positivity constraints; improved agreement in extrapolation regions
- $f_j(x, Q_0) = f_0(x, Q_0)\left(1 + \sum_{k=1,\dots} a_{ik} b_k(x)\right)$,

$b_k(x) = \{\log x\,, \log(1-x)\,, \mathrm{Bern}_k(x)\}$

Summary figures – follow the link to Google drive



Organization of METAvsMCH.pdf (main note)

We start by comparing CT14, MMHT'14, NNPDF3; META900 and MCH900; means and medians; symmetric $1\sigma, 2\sigma$ intervals and asymmetric 68%, 95% c.l. intervals. These comparisons set realistic targets for what the combination must achieve.

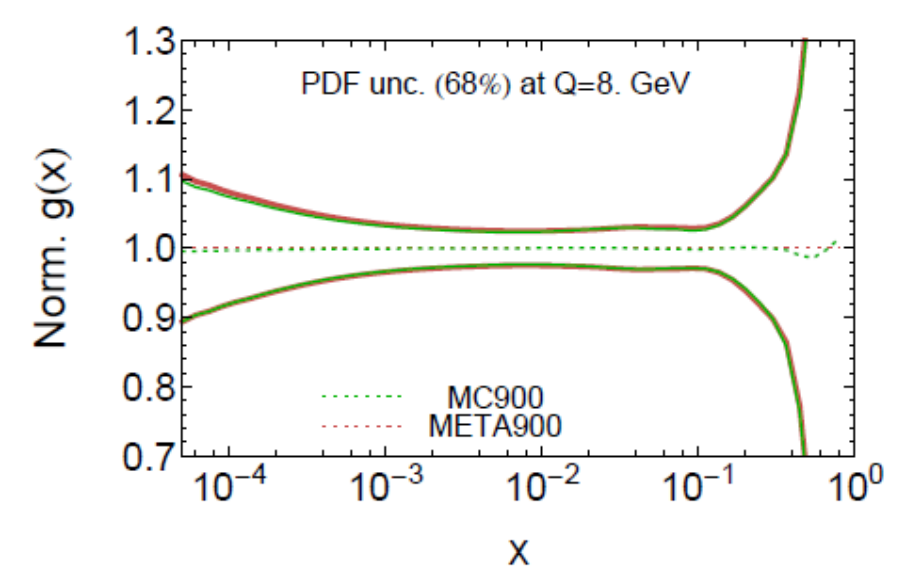
Even with fixed input PDF ensembles, initial differences arise:

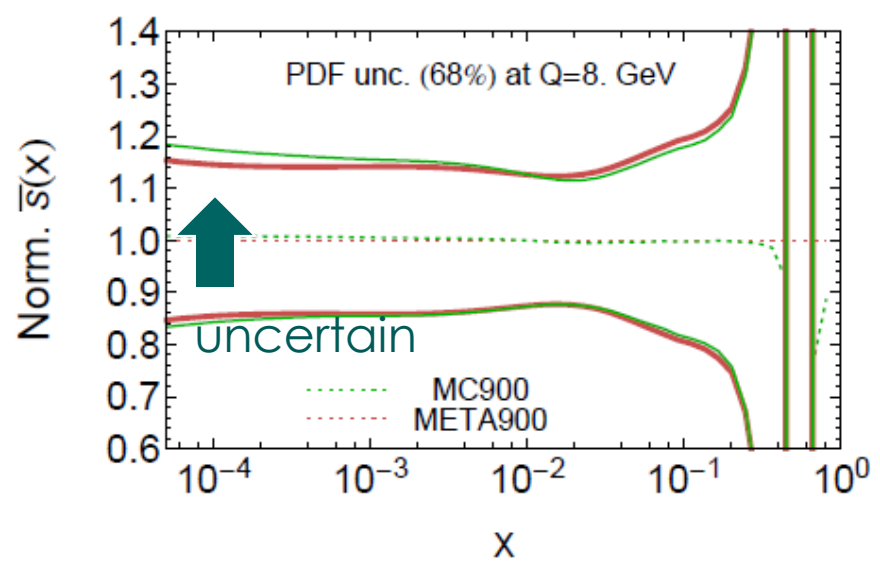
1. From generation of MC replicas
2. From fickle non-Gaussian features

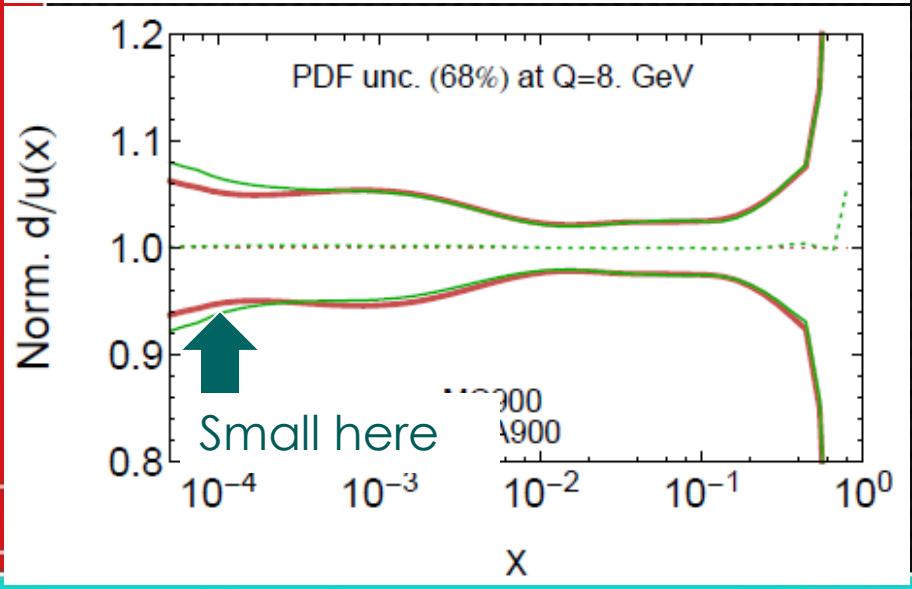
These initial differences are compared to discrepancies introduced by Hessian reduction. Even with META 30, the latter do not exceed the former in all situations.

Our opinion is that META30 performs better than MCH30, while MCH100 performs than META100. Loss of accuracy is neither frequent nor consequential; may occur when the quantity is too small to be practically important (e.g., for $s - \bar{s}$ at $x < 10^{-3}$, sea quarks at $x > 0.3$), or in non-Gaussian regions.

Fig. 8: compare PDF uncertainties of META900 and MCH900



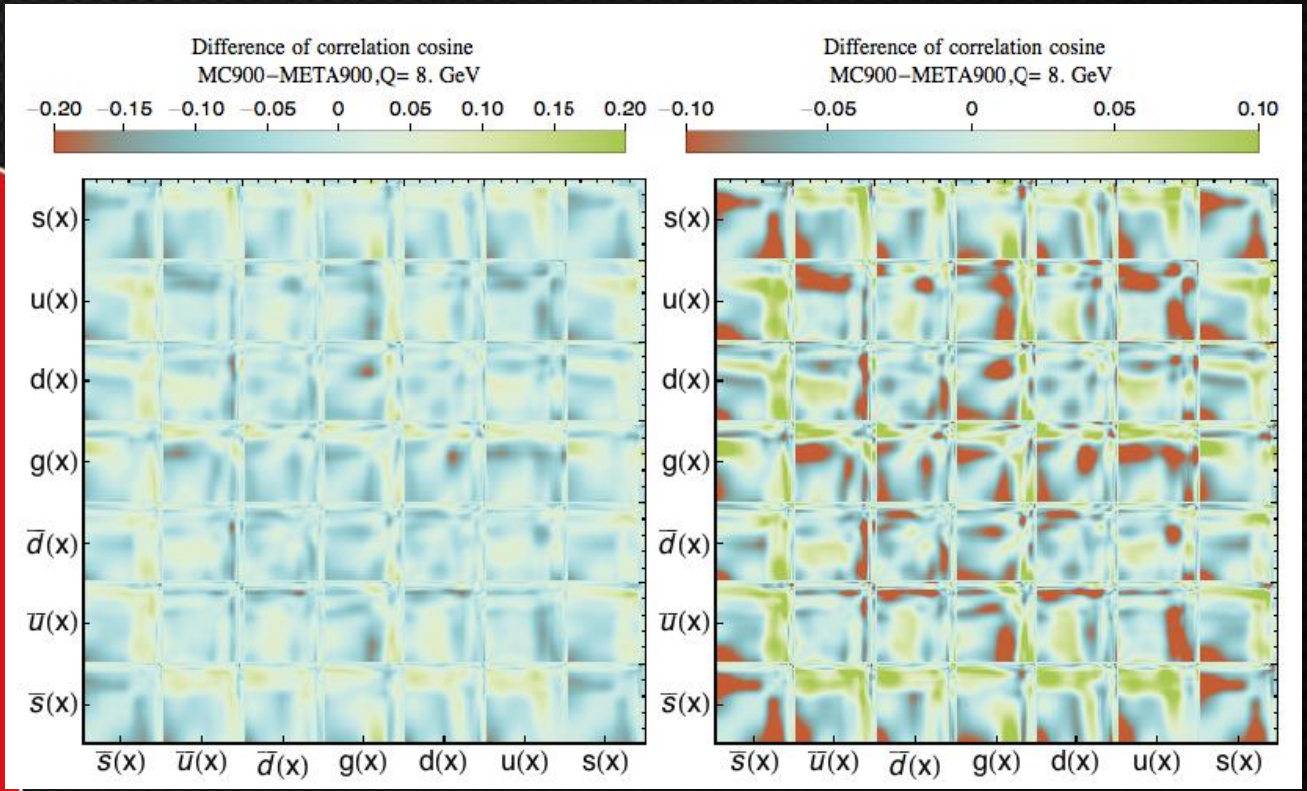




Very good agreement for "large" PDFs
(u, d, g….)

Some differences for poorly constrained
PDFs or **small** PDFs and ratios

Fig. 9: compare PDF uncertainties of META900 and MCH900

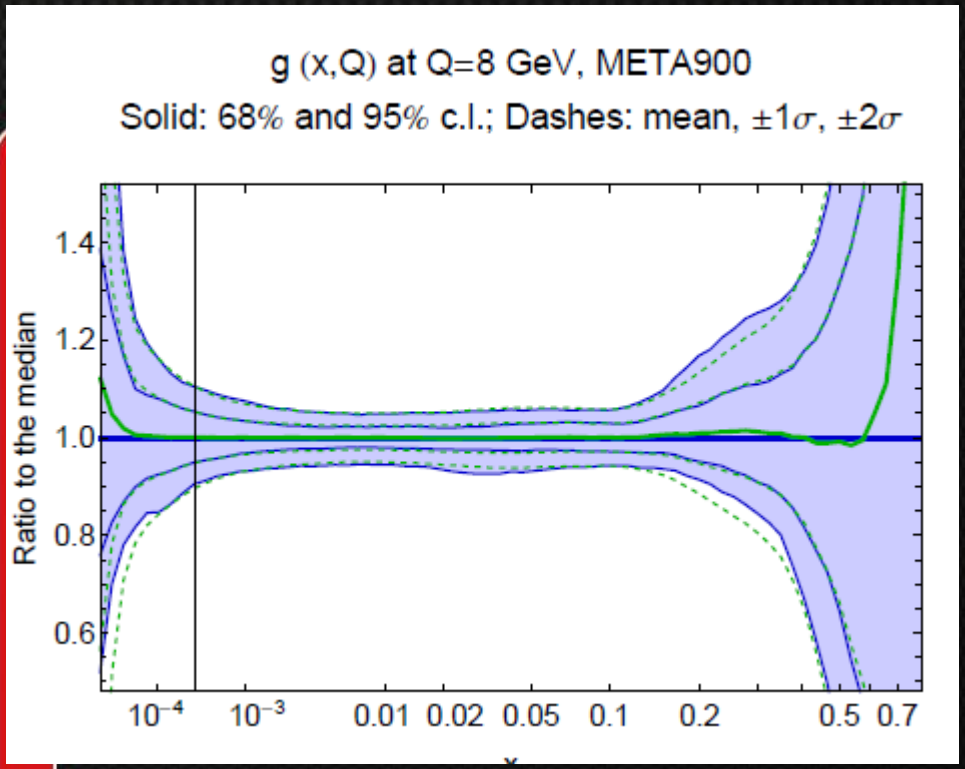


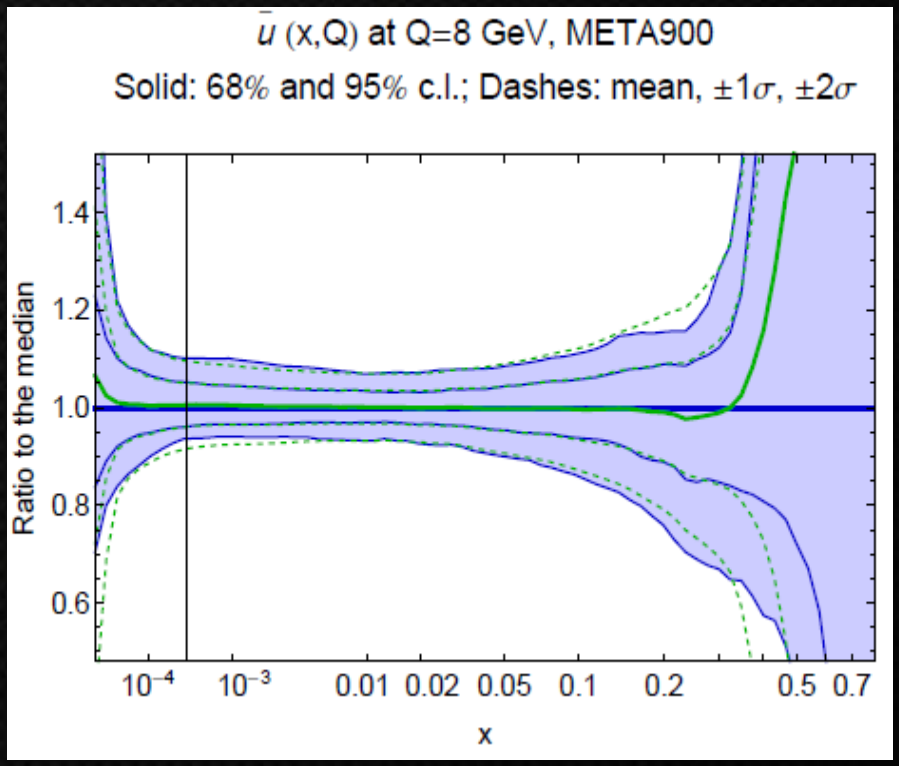
Lower resolution

Higher resolution

Some initial differences between correlations also exist

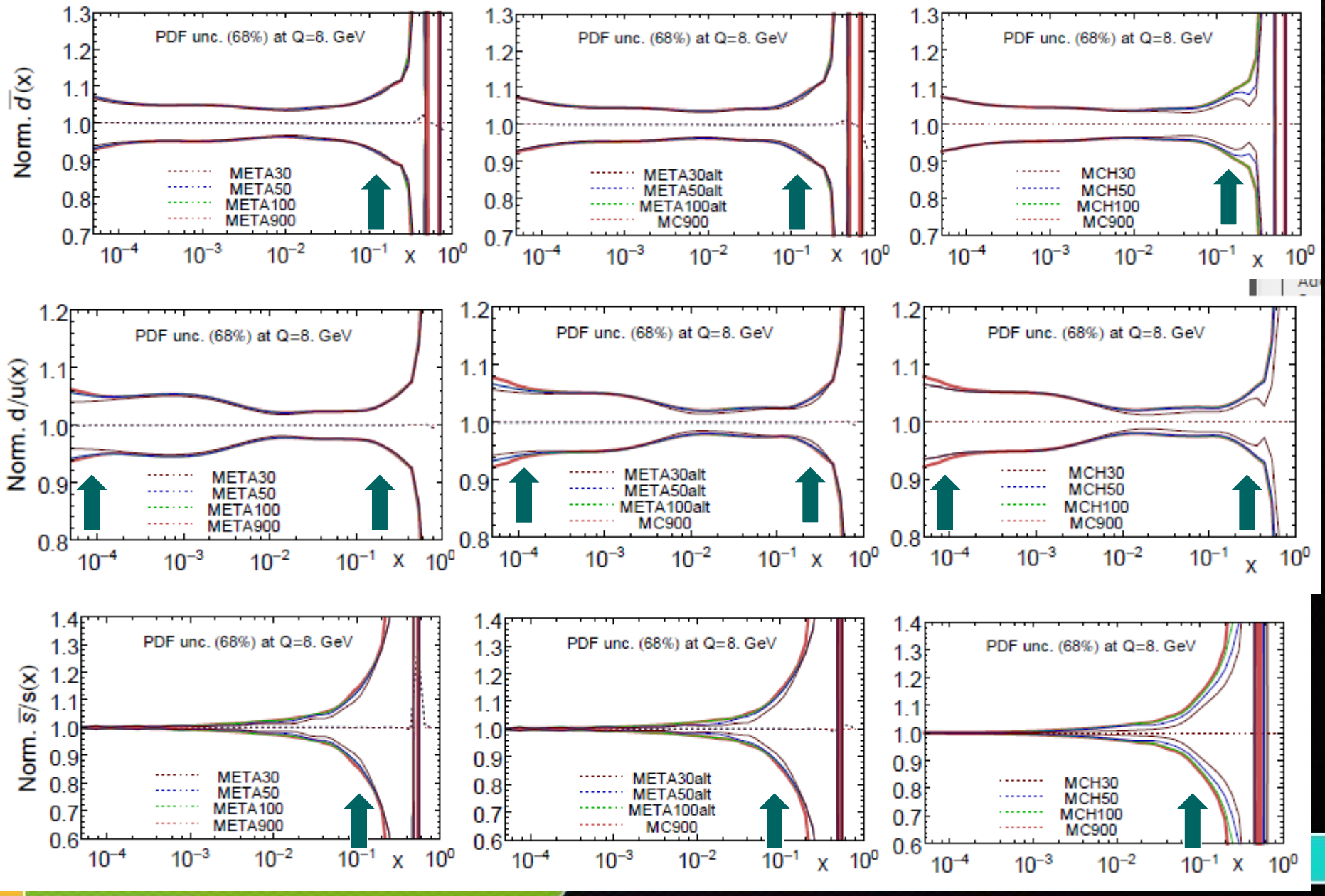
Fig. 10: compare Gaussian and non-Gaussian uncertainties





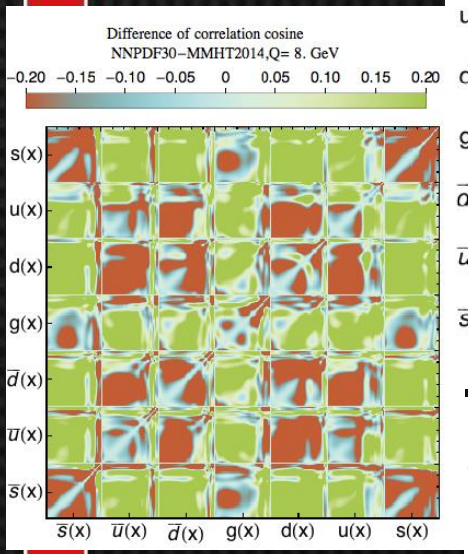
The Gaussian errors are most relevant and predictable. But differences exist even in the "smooth" 900-replica ensembles between the means and medians, 68% c.l. and 1σ intervals, 95% c.l. and 2σ intervals. These differences are small in well-constrained regions and grow outside of these regions.

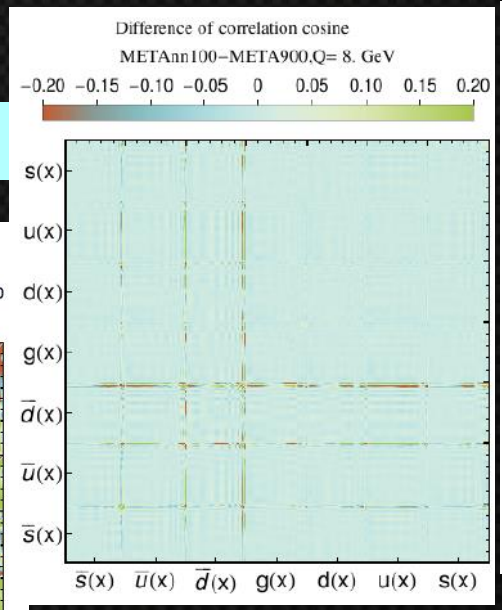
Examples, figures motivating our conclusions 1

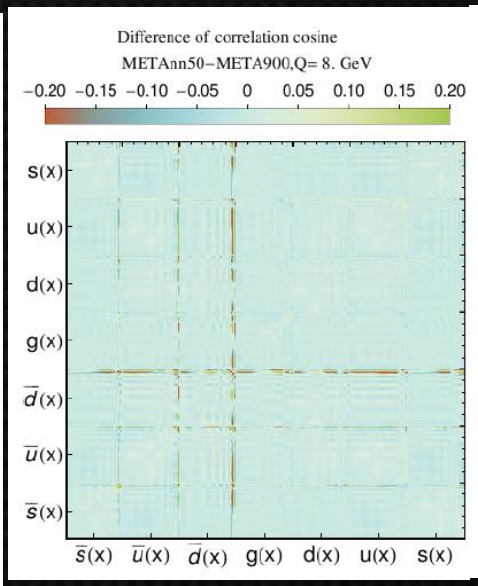


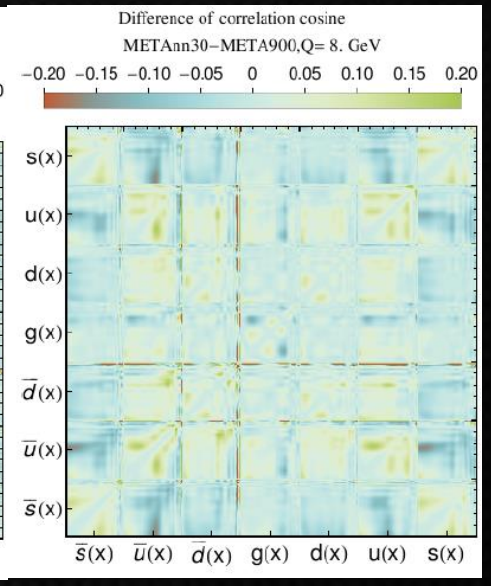
Examples, figures motivating our conclusions 2

META ⇒

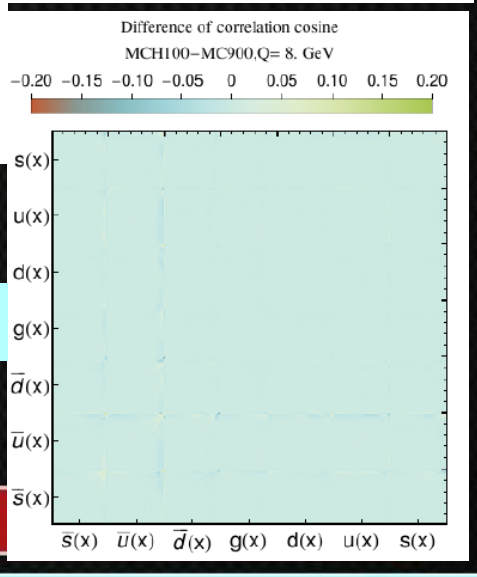


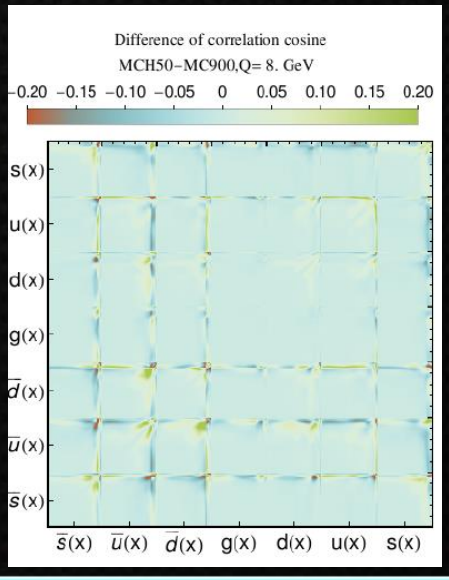


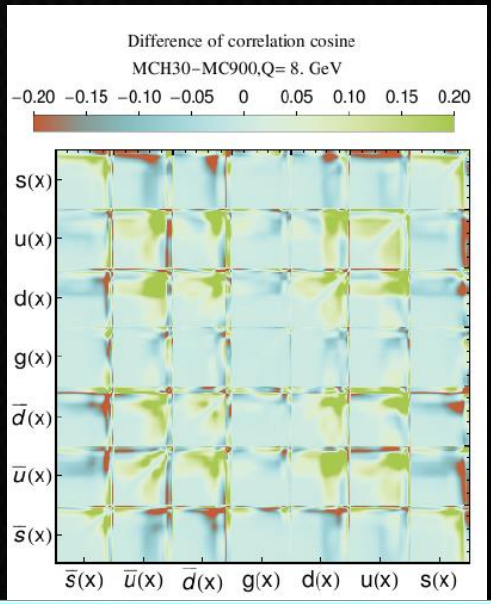




MCH ⇒





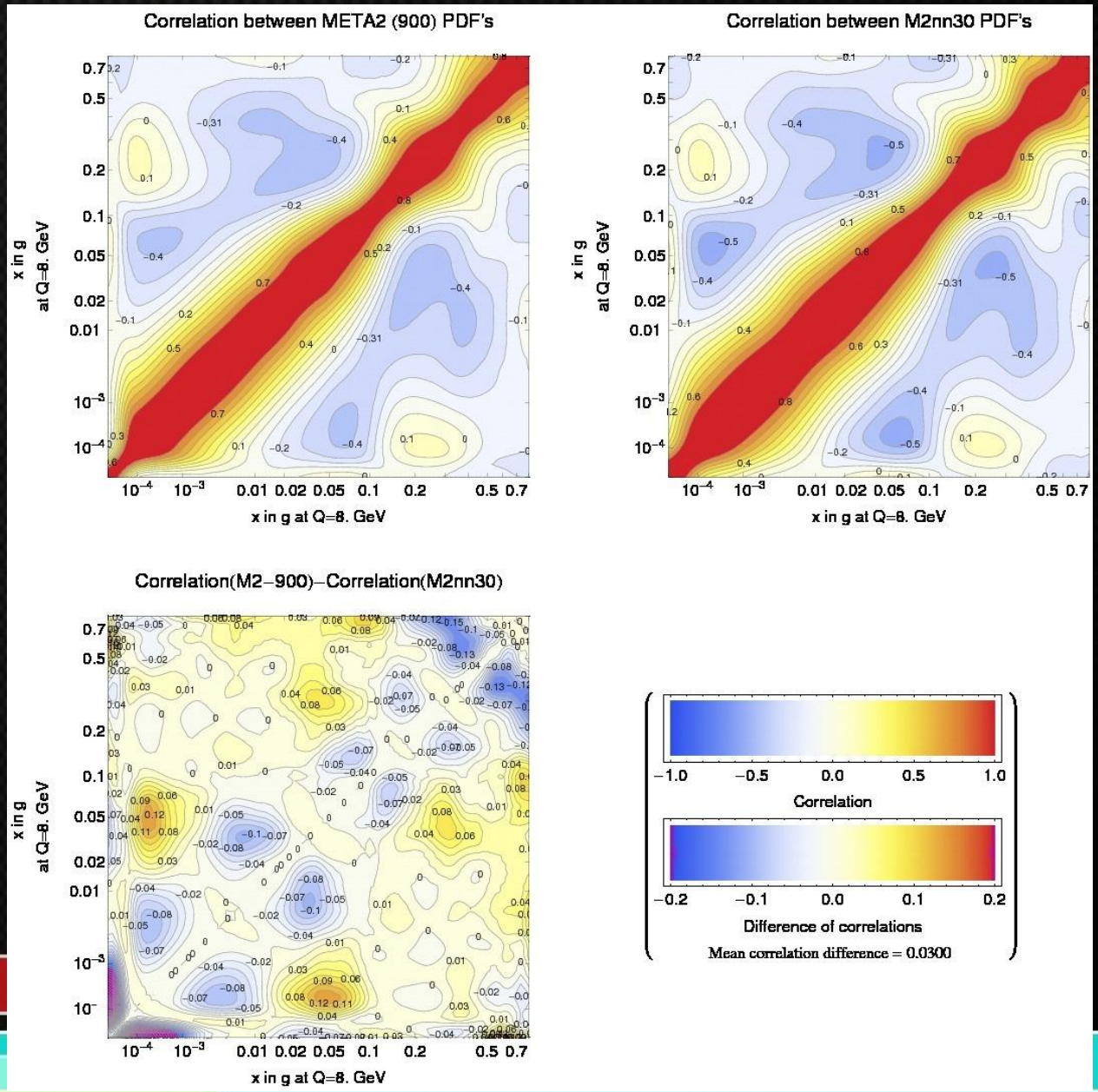


100 eig. 50 eig. 30 eig.

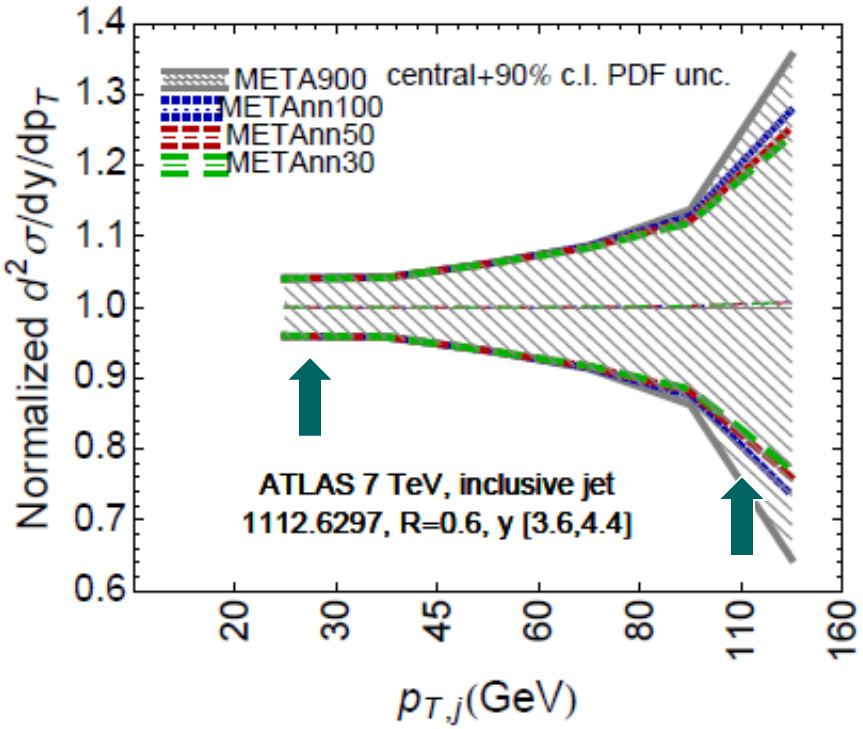
High-resolution plots of correlations – on Google Drive

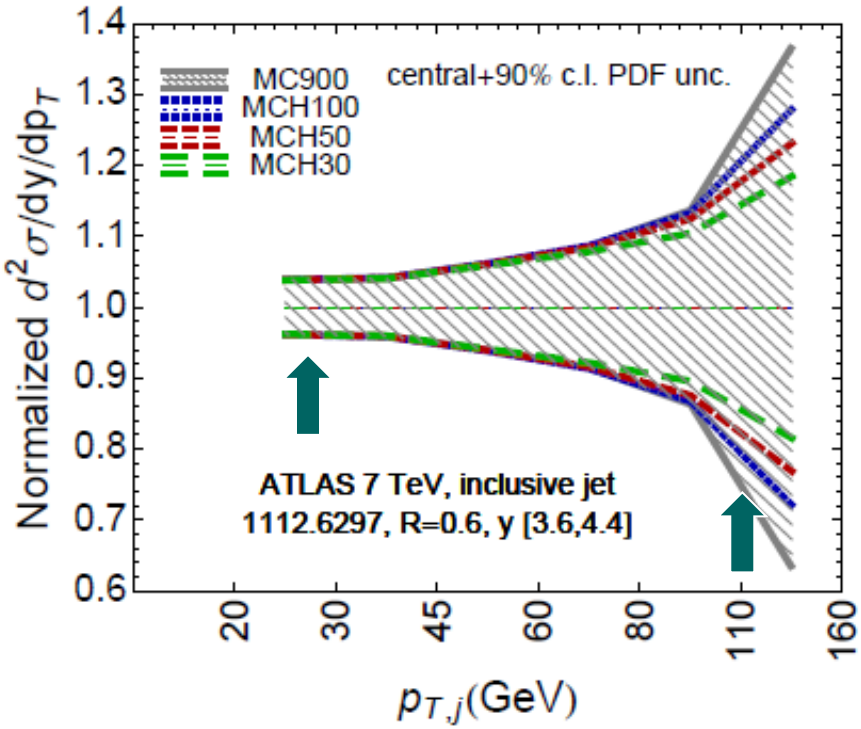
Demonstrate improved accuracy of METAXX in the entire x range

[Density of contours is high at small/large x. Zoom in to see features under overlapping black labels.]



Cross sections: one of the **worst** cases





Good agreement of all ensembles across a wide kinematic range.

Whenever you see differences, they are always in extreme regions where the inputs and Gaussian approximations are less than certain, experimental errors are large. One must resort to detailed non-Gaussian errors if this is important.

Suggestions for the PDF4LHC recommendation

Many future studies are best served by providing a **small** number of combined PDFs that reproduce the input PDFs within the initial uncertainties.

For some precision studies, no more than $5 - 10$ nuisance parameters can be realistically added to parametrize the PDF errors

Proposal for the final recommendation:

A. Hessian PDF reduction as the general technique
B. Two realizations by META and MCH/PCA methods. They will continue to develop

C. Offer three options for using/combining PDFs:
    1. META-30 for applications that require fewer error sets, with mild loss of information in the most extreme regions
    2. MCH-100 for applications that need to retain more information, or when cross checks with META-30 are necessary.
    3. independent CT, MMHT, and NNPDF ensembles (200 ensembles) for very detailed comparisons, such as tests of QCD.